Unburned Carbon Loss (Carbon in Ash)

Boiler efficiency loss from unburned carbon in fly ash and bottom ash, from the fuel ash, the fly-ash share and the carbon in each ash (ASME PTC 4).

Method: ASME PTC 4-2013 Fired Steam Generators §5.14 (unburned carbon in residue); BIS IS 8753 (boiler efficiency)

Input parameters

Unit system: SI

Parameter	Value	Unit
Ash in the fuel, as fired	35.000	%
Share of ash leaving as fly ash	80.000	%
Carbon in fly ash (carbon analysis; LOI overstates it)	2.0000	%
Carbon in bottom ash (carbon analysis; LOI overstates it)	6.0000	%
Gross calorific value of the fuel, as fired	18,600	kJ/kg
Fuel firing rate (for the loss in kW)	50,000	kg/h

Calculated results

Parameter	Value	Unit
Unburned carbon loss, % of heat input	1.8463	%
Heat lost in unburned carbon	4,769.7	kW
Unburned carbon	509.12	kg/h
Unburned carbon per kg of fuel	0.010182	kg/kg

Formula and method

$$m_C = A\,x_f\,\frac{c_f}{1-c_f} + A\,(1-x_f)\,\frac{c_b}{1-c_b}$$

$$L_C = \frac{m_C \cdot HHV_C}{GCV} \qquad \dot{m}_C = \dot{m}_f m_C \qquad \dot{Q}_C = \dot{m}_C \cdot HHV_C$$

Variables

A	ash in fuel, as fired	–
x_f	share of ash leaving as fly ash	–
c_f	carbon in fly ash	–
c_b	carbon in bottom ash	–
GCV	gross calorific value of the fuel	J/kg
$\dot{m}_f$	fuel firing rate	kg/s
L_C	unburned carbon loss, fraction of input	–
m_C	unburned carbon per kg of fuel	kg/kg
$\dot{m}_C$	unburned carbon flow	kg/s
$\dot{Q}_C$	heat lost in unburned carbon	W
HHV_C	heating value of carbon, 14 500 Btu/lb = 33.73 MJ/kg (PTC 4)	J/kg

Method and standards

Unburned carbon loss as in ASME PTC 4 §5.14: carbon in the residue times the higher heating value of carbon, 14 500 Btu/lb, divided by the fuel's gross calorific value. Indian practice (IS 8753) uses the same equation.

Assumptions and limits

- All unburned combustible in the residue is carbon. Enter the carbon from a carbon analysis of each ash; loss on ignition overstates

it (carbonates, sulphur).
- Fly-ash share and carbon contents are averages over the test.

References
- ASME PTC 4-2013 Fired Steam Generators §5.14 (unburned carbon in residue)
- BIS IS 8753 (boiler efficiency)

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online
https://calc.firecad.com/boilers-power-plant/boilers/unburned-carbon-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.